

## EFFECTIVE EVACUATION MANAGEMENT AND MITIGATION PLAN FOR EARTHQUAKE: A CASE STUDY ON LALBAGH AREA OF DHAKA CITY

FATEMA TUZZOHOA<sup>1</sup>, SAJIB PARVEZ<sup>2</sup> & SHAHRIAR RAHMAN<sup>3</sup>

<sup>1,2</sup>Research Scholar, Faculty of Disaster Management, Patuakhali Science and Technology University,  
Dumki, Patukhali, Bangladesh

<sup>3</sup>Lecturer, Department of Geo-information Science and Earth Observation, Faculty of Disaster Management, Patuakhali  
Science and Technology University, Dumki, Patukhali, Bangladesh

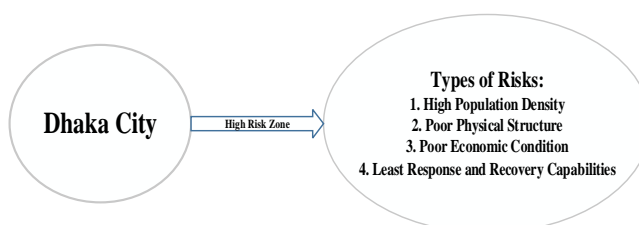
### ABSTRACT

Bangladesh is one of the most earthquake prone countries in the world. Earthquake has both direct and indirect negative impacts on human life and socio-economic development of a country. The record of approximately 150 years shows that Bangladesh and the surrounding regions experienced seven major earthquakes ( $M_b = 7$ ). The study area (Lalbagh) is considered as one of the most highly earthquake vulnerable parts of Dhaka city. The research findings will help to explore the potential evacuation route and physical planning activities, mitigation plan for the dwellers of the study area and involvement of community, find out the potential places with critical facilities like health services, search and rescue operations, create awareness among community people to contribute for preparation and use of the map, create a new window for the policy makers of our country and to ensure effective earthquake management and sustainable physical development.

**KEYWORDS:** Disaster, Earthquake, Emergency, Evacuation Route, Mitigation

### INTRODUCTION

Lalbagh is vulnerable to earthquake disaster; a tremor measuring 7 magnitudes on the Richter scale may destroy about 35 percent buildings and kill around 25,000 people (Figure 1). People might perish in structural collapses approximately 22,000 to 28,000 while the number of seriously injured may range between 86,000 and 107,000 depending on what time of day earthquake strikes, while the number of seriously injured may range between 86,000 and 107,000 (ADPC, 2005). A recent study showed that the economic loss of earthquake of 8 magnitude is estimated about 1.76 billion U.S. dollars for Dhaka city (Saha, 2007).



**Figure 1: Earthquake Risks of Dhaka city (ADPC, 2005)**

Geographic Information Systems (GIS) have become integral tools for disaster management, and are currently utilized in all four phases of a disaster: mitigation, preparedness, response, and recovery (Cutter, 2003). The main reason

for thinking an evacuation road network analysis is to increase awareness among people who are living in a high risk zone and must need to have a family level evacuation plan as well as community or government level emergency response plan (NFPA, 2007).

Many of seismic-tectonic studies have been undertaken on the area comprising the Indo-Burman rangeland their western extension and in the northern India (DCC, 2011). Major active fault zones of the country have been delineated through geological trenching and dating methods (Haque, 1990). A seismic zoning map of Bangladesh has been proposed in 1979 by Geological Survey of Bangladesh (GSB) dividing the country into three seismic zones which was accompanied and outline of a code for earthquake resistant design (DCC, 2011). Later, a new updated seismic zoning map and detailed seismic design provisions have been incorporated in the Bangladesh National Building Code (BNBC, 1993). A seismicity map of Bangladesh and its adjoining areas has also been prepared by the Bangladesh metrological department (BMD) and Geological survey of Bangladesh (GSB). Bangladesh has been classified into three seismic zones with zone-3 the most and zone-1 the least vulnerable to seismic risks (Banglapedia, 2011). Though Dhaka is situated in the medium vulnerable zone according to the seismic zonation map, it is a high risk zone due to massive population density and rapid urbanization (Figure 2).

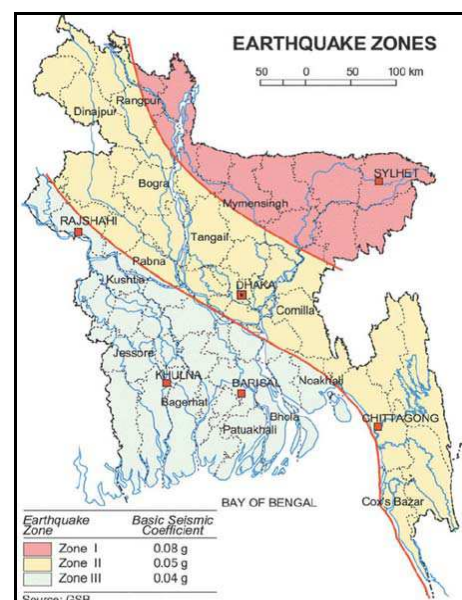


Figure 2: Earthquake Zone in Bangladesh (Banglapedia, 2011)

## STUDY AREA

A study on the analysis of evacuation road network in Dhaka City of Lalbagh area has become an important aspect due to its enormous vulnerability towards an earthquake of magnitude 7.5. The historical background and recent foreshocks added a new dimension with it. But no such study has been done in this city even in the country. The findings of this research will help to explore the potential evacuation route for the dwellers of the study area and involvement of community as well as local govt. authority will enhance the provision of governments response planning.

The study area of the research is water works road of ward no. 29 under Dhaka South City Corporation. Both of ward 29 area of Dhaka South City Corporation (DSCC) and the study location water works road is shown in bellow the Map (Figure 3). Lalbagh is located at 23° 42' N, 90° 22' E. It was formerly larger, with a total area of 9.14 km<sup>2</sup> (Banglapedia, 2011).



**Figure 3: “Water Works Road” and also the Ward 29 of DSCC**

(Source: <http://www.dhakasouthcity.gov.bd/>)

## THE VULNERABLE CAUSES

Water works road and its surrounding buildings under ward no. 29 of Dhaka South City Corporation was previously ward no. 65 of Dhaka City Corporation, depending on several criteria the study area was selected. The total numbers of people need to be evacuated during an earthquake emergency in the study area is 5,219 and total number of households are 1,056 (BBS, 2011). The earthquake disaster risk index has placed Dhaka among the twenty most vulnerable cities in the world. Dhaka especially the old Dhaka (Lalbagh) with its large population and enormous poorly constructed and dilapidated structures signifies extremely vulnerable conditions for massive loss of lives and property in the event of a moderately large earthquake. Some criteria are important factors for the vulnerability of earthquake in Lalbagh,

### Infrastructure

This area is considered as one of the most vulnerable part of Dhaka city because of some existing physical parameters as followed:

- Consists of buildings that are more than 100 years old;
- Original buildings were 2 or 3 storied but 4-6th floor have been constructed on the old structure;
- Most of the buildings are used for both residential and commercial purpose as well;
- All the buildings have very narrow stairways;
- Width of most of the buildings are 10-12 feet;
- 8-12 families live in a 4-6 storied building;

According the survey, about 41% of buildings in Dhaka were found with heavy overhangs (ADPC, 2005).



**Figure 4: Typical Heavy Overhangs Foundation in the Lalbagh City (A: Do Not Follow Building Code; B: Heavy Overhanging Buildings Which More Vulnerable)**

According to the Turkish method [Bommer et al. (2002), Tesfamariam and Saatcioglu (2010)] , the level of building damage during earthquakes depends on the quality of construction materials, maintenance of buildings, apparent building quality and workmanships Earthquake specialists can classify a building's quality as roughly good, moderate, or poor (Sucuoglu and Yazgan, 2003). In this study, it has been found that the most poor quality buildings are present in Lalbagh.

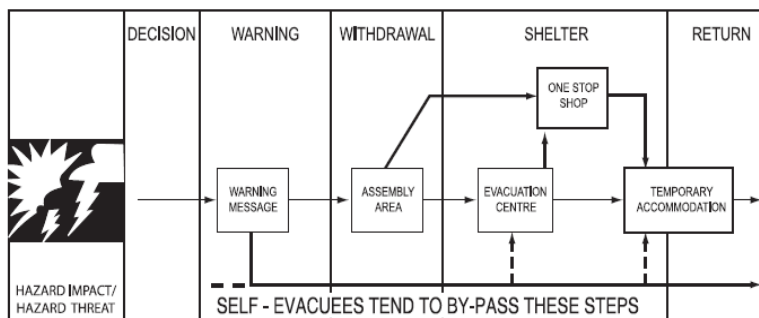
### **Geological Formation**

There were several shakes of earthquakes in Dhaka in high Richter scales during the geological past (ADPC, 2005) Minor shocks are very frequent in the recent years in lalbagh city.

### **EVACUATION AND ITS PRINCIPALS**

Evacuation is a risk management strategy which may be used as a means of mitigating the effects of an emergency. However, evacuation plan will be effective when it must be correctly executed and planned. The process of evacuation is usually considered to include the return of the affected community (EMA, 2005). There are five stages to be considered for evacuation (Figure 5):

- Decision to evacuate
- Warning
- Withdrawal
- Shelter and
- Return.



**Figure 5: The Evacuation Process (EMA, 2005)**

There should be determination of legal or other authority to evacuate, establishment of a management structure, clear definition of roles and responsibilities, development of appropriate and flexible plans, effective warning or GIS mapping and information system to easily evacuate the community people.

## EVACUATION CONTINGENCY PLAN FOR LALBAGH

In time of a disastrous situation any large-scale evacuation is not a common process. so people were not warned because of there were no emergency systems available. For the purpose of planning, all evacuations may be considered to be one of two generic types (EMA, 2005). Immediate Evacuation is one type of resulting from a hazard impact, that for immediate action, thereby allowing little or no warning and limited preparation time. Earthquake, Fire accident, hazardous materials accidents/incidents, air crash and wildfire are examples of events that may require immediate action, another pre-warned Evacuation is also resulting from an event that provides adequate warning and does not unduly limit preparation time. Examples of this type of event main include cyclone, flood and storm surge.

The Major roles assigned to DCC in relation to National Earthquake Contingency Plan. The major responsibilities of DCC with regards to earthquake Contingency planning are to ensure a quick and efficient management system which would enable speedy recovery of the Lalbagh's community normal functions after any earthquake incident. DCC(2011) undertakes the Lalbagh area development projects to ensure safety of city dwellers, take this area crisis planning (pre-positioning of essential elements and evacuation areas for response & recovery), prepare plans in advance for this area utilities (telecommunication, Power supply, Gas lines, waste disposal etc.), maintain open areas, green areas, parks, recreation etc of city dwellers, operate emergency operation center during earthquake incident, provide emergency services during earthquake incident, ensure welfare, food and nutrition for the victims and authentic information to mass media must be proper dissemination.

## EVACUATION CONDITION FOR LALBAGH

Dhaka South City Corporations should develop its own Agency level Earthquake Contingency Plan to define roles and responsibilities of various units, officials within City Corporations. The Earthquake Contingency Plan requires similar planning at all levels of government and by a number of key ministries and line departments are working to reduce the impact of earthquake and mitigate the effect, prepared evacuate plan for this area. While respective agencies need to have dedicated champions to undertake planning and implementation; Ministry of Food & Disaster Management will have a difficult task in coordinating and providing technical assistance. DCC is providing additional resources in terms of technical as well as financial resources qualified manpower to undertake assigned tasks under the Earthquake Contingency Plan. Capable and committed staff with appropriate financial resources, facilities, equipment and supplies is required to

implement an effective, long-term program based on the plan. Study alternate transport arrangements in case of earthquakes and develop route maps are so much needed that's why DCC working this job.

The City Corporation does not pay attention to or takes too much time to attend to the individual problems of the citizens of different wards. Even when they do respond, they do so late, and are far removed from the realities of the citizens.

- The City Corporation should incorporate public opinions to develop a better urban planning and delivered better services.
- Citizens are not much aware of the functions and functionaries of the City Corporation, and so, they are not engaged in the activities of the DCC.
- There is hardly any prior notice on the proposed or undertaken activities[The Corporation gets their notices published in the national dailies on regular basis. As a matter of fact, citizens hardly read the advertisements or the notices of the Corporation.]
- Citizens are mostly not sensitized about the activities of the City Corporation. As regards the responsibilities of the City Corporation, citizens mostly want the City Corporation to keep their areas clean specially cleaning of roads and roadsides.
- Citizens have a perception that corruption is a barrier to the proper accomplishment of the activities of the City Corporation.

The Earthquake Contingency Plan will not, and cannot, address all circumstances in this Lalbag's area (e.g. long-term recovery plans).The Plan assumes that the line agencies will have Mandatory provisions and national capacity to deal with assigned tasks. District authorities can be granted through a gazette notification but Lines of authority need to be finalized and communicated to all levels.

## EVACUATION STRATEGIES

For the respective area the following strategies are to be adopted in plan implementation:

- Setting up a strong organizational set-up to identify and assess earthquake hazards, analyze vulnerability , assess risk and loss estimation;
- Development & Plan of institutional capabilities to translate earthquake risk reduction into preparedness and Response Plans;
- Establish a consistent, participatory approach to the management of earthquake emergency responses;
- Propose a concept to integrate Disaster Management planning into the Operational Plans of DCC for this area ;
- Undertake education and training programs on all phases of Disaster Management for all levels of this area to build the capacity of professionals;
- Develop a mechanism to improve the relationships with non-government organizations to address mitigation, preparedness, response and recovery phase effectively;



- Transfer the state of art of technologies and knowledge and necessary to support institutional operations and implement operation plans.

Adopting the following strategies, the community people will early response or evacuate during earthquake and to establish their capacity or mitigation process.

## RESULTS AND DISCUSSIONS

Evacuation Road Network map is very important tool for timely and effective emergency response operation. However preparation of an evacuation route map considers some important steps. To prepare an effective evacuation route map the research focuses on the safe places to assembly and determine during emergency and also define the safe place at shortest distance. To determine the community participation in map preparation and strengthen emergency response planning on Standing orders on Disaster (SOD) process.

### IDENTIFICATION OF SAFER PLACES (OPEN SPACE AND CRITICAL SERVICE PROVIDER)

Safe places where people can gather during an emergency are identified on the basis of some parameters. The mostly followed method is OSHA (Occupational Safety and Health Administration) approach by the US department of labor. To the extent possible under the conditions, ensure that evacuation routes and assembly place during emergency meet the following conditions:

- These places are well accessible for road connectivity;
- The number of evacuating people, place should be wide enough to accommodate;
- Due its width and regular maintenance, unobstructed and clear of debris at all times; and
- Expose evacuating people are unlikely to additional hazards.

These places include places for emergency assembly for example open field, park, eidgaha etc, as well as buildings with critical services like hospitals, mosques, schools etc.. Only three open spaces found to gather during an emergency in ward-29 boundary of Dhaka South City Corporation. These are: Rahamatganj Football field, Islambageidgah and a park. All of these three open spaces are well accessible and well capable of holding all the people of Water Works Road. Though these open spaces need reformation and repair.

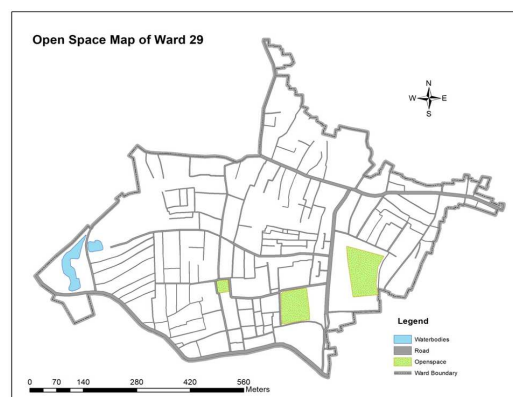
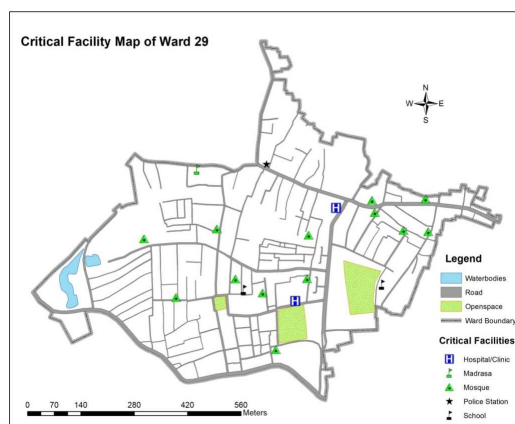


Figure 6: Identified Open Spaces in Ward-29 of DSCC

However, the structures with critical facilities are selected on random basis because few of them have well accessibility but all of them are shown in the map (Figure 6). It is very much crucial in providing sufficient shelter, security as well as food and health care services. There are only two hospitals are found in the area of ward-29. Almost 15 mosques are found where there is well accessibility as well as those buildings are quite well structured. Only a police station was found in the area. Two schools are available but they may not be suitable for taking shelter (Figure 7).

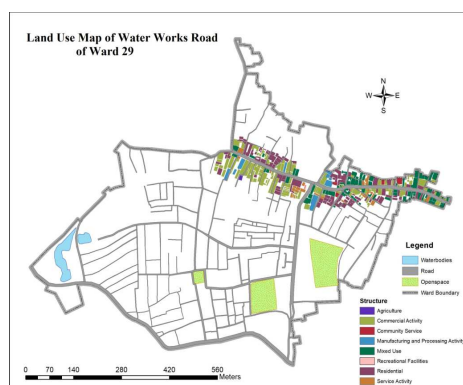


**Figure 7: Critical Facilities Map of Ward-29**

Evacuation place considers different factors for earthquake rather than cyclone and flood. This is because earthquake may happen several times in a row. A major earthquake will happen; it may take only few seconds to minute destroy many properties. Evacuation within this time can save many lives. If a community people knows where to go during an emergency will help them to decide their destination. As a result, the shortest distances are taken priority rather than their quality of services. Here saving life is the most important issue.

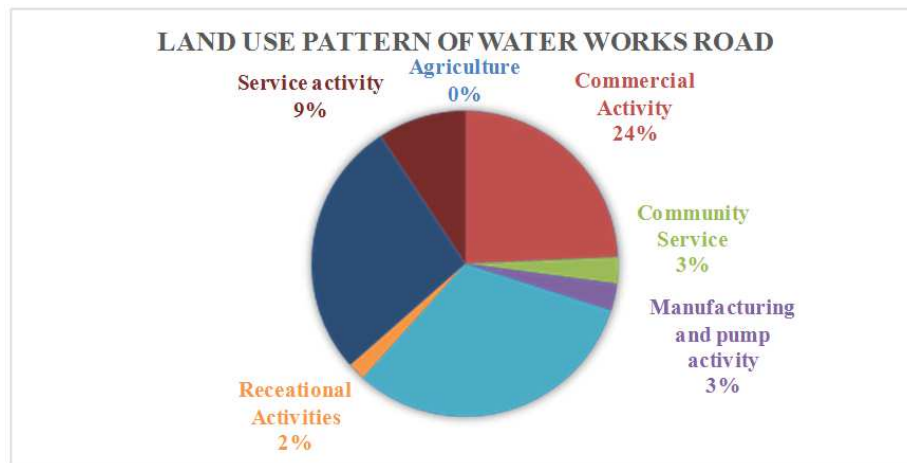
## DETERMINATION OF NUMBER OF PEOPLE TO BE EVACUATED

Dhaka is the most urbanized and densely populated district of Bangladesh. So the study area water works road under ward-29 is not tending to be different from that. The total population of water works road is about 5219 while male is 3304 and female is 1,915. It lies in the urban part according to its socio-economic condition and facilities provided by Dhaka South City Corporation (BBS, 2011). Total number of household is 1046. There most of the buildings are mix-used. Only a few are used for only residential or only commercial (Figure 8). Education status is not significantly high in this region as only 23% people are graduated while a significant number has taken only primary education. So it is a serious issue to be considered for evacuation.



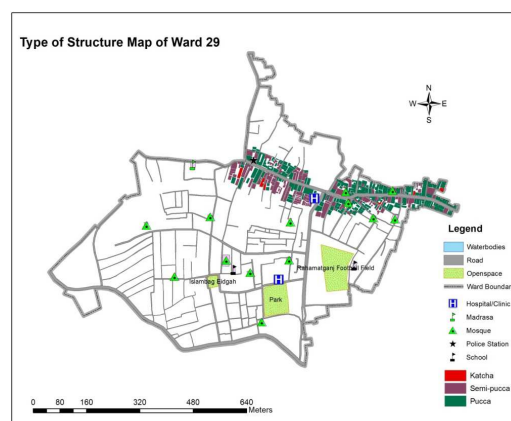
**Figure 8: Land Use Map of Water Works Road of Ward 29**





**Figure 9: Land Use Pattern of Water Works Road**

There are different types of structures in water works road of ward 29 as classified into katcha (used normal materials), semi-pucca and pucca (used brick, cement, concrete etc.). In the study area most of the buildings are pucca (Figure 10).



**Figure 10: Type of Structure Map of Water Works Road of Ward 29**

Building height is also an important factor to be considered for evacuation planning. High rise buildings occupy large number of people in consideration of its height and space. So it is quite risky to evacuate large number of people from the same compound. Most of the cases people start move around roughly in case of earthquake and fire emergency. In the study area there are not so many high rise buildings in consideration of the floor area ratio but most of the buildings are established closely with the adjacent buildings. Almost two or three families live in a floor while the average building width is eight to ten feet. So having a family level evacuation plan is very much helpful as emergency lifesaving activities. If an earthquake occurs, the Lalbagh's community may need to evacuate. By practicing and planning for evacuation, communities people will be better prepared to respond appropriately and efficiently to signs of danger or to directions by civil authorities.

Community people must take a few minutes with the members of family to discuss a home evacuation plan and sketch a floor plan of the each family; walk through each room and discuss evacuation details. Plan a second way to exit from each room or area, if possible. Family member's should mark where the emergency food specially dry food, drinking water, medicine, first aid kits, and fire resisting elements such as fire extinguisher are located and they also mark the utility

switches or valves so that the family members can be turned off, if possible. Indicate the location of the family's emergency outdoor meeting place.

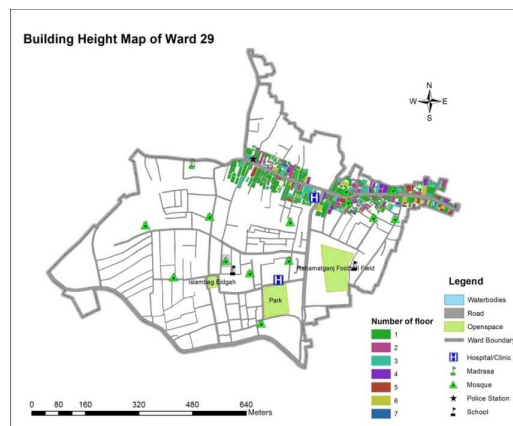


Figure 11: Type of Building Height Map of Water Works Road of Ward 29

## IDENTIFICATION OF SHORTEST ROUTE FOR EVACUATION

O-D (origin-destination) method determines the shortest route toward reaching a safe place for assembly is identified and the principle of O-D method is used to go far away to a destination through different road connectivity. It depends on specific road and its highest allowed speed per hour. The victim has to choose the safe place within shortest distance considering the damage potentiality of an earthquake and must think for an open space and later to think about getting critical facilities.

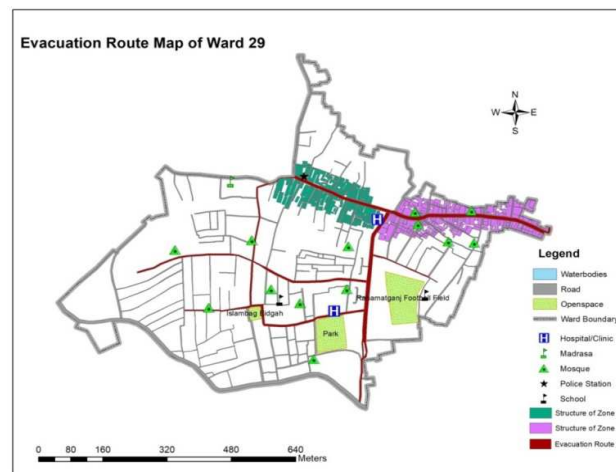


Figure 12: Evacuation Route Map of Ward-29

Practically the total households of Water Works Road are divided into two zones as shown in figure 5.3. Identified open spaces in ward no. 29 of Dhaka South City Corporation are three open spaces (Figure 6). The largest one is Rahamatganj football field. Medium one is the only Park of ward-29 and rest one is Islambagheidgah. Eastern part of Water Works Road is defined as zone-2(purple) and western part is zone-1(green). Rahamatganj football field is selected as the evacuation space for zone-2 and other two is allocated for zone-1. However, road connectivity is shown through the red line in the evacuation route map of ward 29. Most of the buildings with critical facilities are almost near about the evacuation route (Figure 12)

## **REASONS OF COMMUNITY INVOLVEMENT IN MAP PREPARATION**

Community is the prime user of an evacuation map. All efforts are given to prepare an evacuation route map to save community people. If they are involved in preparing the map, it will create a great interest within them to rethink about their responsibility towards use of it. They will be quite aware of the vulnerability factors of earthquake and fire for their community. If emergency service providers call them for any sort of help and awareness raising program, they will definitely respond to it spontaneously. If every family create and practice a family evacuation plan, it will be more fruitful to save life. If community people start moving towards a safe place for evacuation by themselves, it will definitely work as a great sign of community non-structural resilience.

## **STANDING ORDERS ON DISASTER (SOD) WITH COMMUNITY PARTICIPATION AND MOBILIZATION**

In Bangladesh no significant study has been done on long term benefit of community involvement during preparation of an evacuation route map. Thus this research can greatly help in better performance of “Standing orders on Disaster (SOD)” as well as provision of “Emergency operations: overall command and control” mentioned in National Plan for Disaster Management 2010-2015 by the Government of Bangladesh. This part will focus on how community participation can enhance SOD.

## **DISASTER RESPONSE COORDINATION GROUP IN LOCAL LEVEL**

At the national level there is a good indication of the government engagement in disaster risk management through coordination of different ministries, state departments, NGOs and civil society organizations. At the local level, the Disaster Management Committees (DMC) play key role for disaster risk management. Ward Disaster Response Coordination Group (WDRCG) is formed in different places of Bangladesh but actually it does not work in Lalbagh due to the lack of mobilization. If it exists actively, it can better facilitate in emergency response operations. This committee may include the members of ward commissioner office, ward committee members, volunteers from the Lalbagh’s community. Community is the victim of an incident and also first responder to that event so effective preparedness can make the actions more fruitful. Trained community responder team can work without time and information dissemination constraints. Community participation can help in government’s provision on emergency management for that area and Community Based Disaster Risk Management is the way to build a culture of safety.

## **MANAGEMENT AND FORMATION OF EMERGENCY OPERATION CENTRE**

District Commissioner (DC) of Lalbagh city will open shelter space/ Emergency Operation Centers in times of necessity to save human lives and properties. DCC will organize and open Emergency Operation centers at carefully selected places like multipurpose disaster shelter, educational institutions, community centre and other government places in consideration of the nature of disaster. The concerned Municipality Member/ Commissioners will be in charge of the centre and at least 10 (ten) local volunteers will assist the DCC in coordinating, organizing and managing the centre. Required accommodation, health and sanitation, water supply and lighting arrangement should be ensured. For the supply of pure drinking water, shallow tube-well should be sunk with the help of DPHE. Every step should be taken for the prevention of epidemics. First aid and health centers should be opened with the help of Health and Family Planning Officer. Local Red Crescent in the perspective area, Community Preparedness Program (CPP), representatives of

designated organizations will ensure all cooperation in the centre.

In case of earthquake or fire accidents, people need to go to a safe place rather than having other facilities. This process will seem to be very easy if community people move for evacuation by themselves and the destination is well known. A good quality evacuation route map can make it easier.

## ENHANCEMENT OF RESPONSE PLANNING OF NATIONAL PLAN FOR DISASTER MANAGEMENT

Involvement of community people and local leaders in emergency operation will bring it in a new focus for evacuation plan. Its Pre-disaster Phase activities, Emergency Response Phase and Early Recovery Phase activities will be easier. If people can be evacuated from their place in time, then all other activities will become so easy such as:

Fire Service and Civil Defense (FSCD), Armed Force Division (AFD), Directorate General of Health Services (DGHS), Disaster Risk Reduction (DRR), Bangladesh Telecommunication Regulatory Commission (BTRC), Bangladesh Police (BP), Road and Highway Department (RHD), Bangladesh Inland Water Transport Authority (BIWTA), Bangladesh Chain Amino Acid (BCAA), Civil Aviation Authorities, Office of Divisional Commissioners, Local Government Bodies, Utility Agencies. These organizations are jointly working for Government for the following Emergency Response Phase activities which will greatly enhance through community participation:

- As the earthquake incident command system to facilitate mobilization where necessary under the command of AFD and Net working with organizations under ICS;
- Execute operation surveillance continuously covering all the earthquake affected areas;
- Expansion of National EOC to address the needs after earthquake disaster event and facilitate EOC operations, Daily or periodic reporting by stakeholders;
- Mobilize ICS teams at lower level command structure.

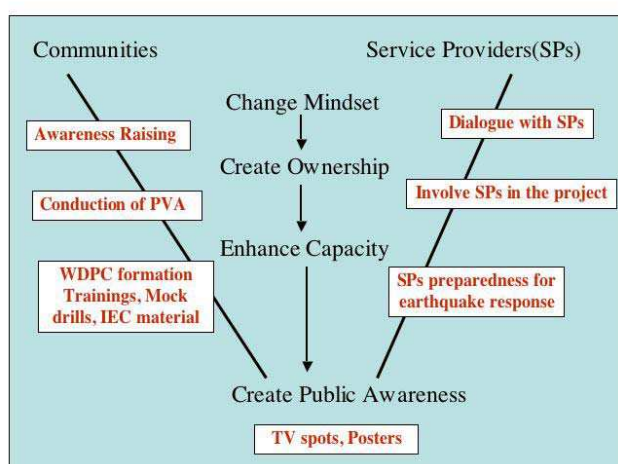


Figure 13: Linking Communities and Service Providers (SPs)

## PROTECTION MEASURES

Earthquakes strike without warning, it is important to act now. Know how to respond, and what to do, by using

the evacuate route to save your life especially. The real cause of death or injuries during earthquakes is usually not the ground shaking. If any earthquake or shaking may occur in Lalbagh city, then most deaths are the result of buildings collapse, falling debris, and objects like light or pieces of chimneys. Long term mitigation measure includes: Constructing earthquake-resistant community buildings and buildings (used to gather large groups during or after an earthquake) like hospitals, prayer halls, schools and supporting nongovernmental organization in various aspects of disaster mitigation, preparedness and prevention and post-disaster management of Lalbagh. DSCC should prepare a detailed seismic risk map especially for Lalbagh city considering its high population density and poor physical structure. There should be appropriate specifications in construction practice and standard building codes to safety and making all public utilities like electricity lines, water supply systems, communication networks etc. Educational curricula should involve in schools to include disaster related topics and architecture and technical training in polytechnics and engineering institutions.

Medium mitigation measure includes: In the area of disaster management, networking of local NGOs working. NGOs workers should be trained up to strengthen their capabilities and capacity. In highly seismic zones, retrofitting of weak structures. It is very important for Lalbagh city as their many building are not able to survive against ground shaking. The communities involved in the process of disaster mitigation through education and awareness.. In this perspective, Community-based Earthquake Risk Mitigation process should be initiated by promoting awareness among community people.

There should be some short term measure to reduce the vulnerability in individual level, because earthquake has no warning system. Short term measure includes: Heavy objects should be placed at the ground level and other breakable objects in safe place. Electrical or gas lines should be properly designed so that people easily evacuate the place. Hazardous liquids or materials must be stored securely. Near the windows, beds should not be placed. Every member especially children of the family should know how to switch off gas mains and electricity at the time of emergency and they should know how to use first aid box because outside help may be delayed. As the reason every family should keep a first aid box always ready.

## **CONCLUSIONS AND RECOMMENDATIONS FOR EARTHQUAKE IMPACTS MANAGERMENTS**

Evacuation planning is complex because there are many stakeholders with different perspectives, there are multiple requirements, and evacuations are nearly always surrounded by uncertainty and confusion. Effective evacuation route plan can make it easier. The evacuation route as determined in this study will greatly help in most effective ways to minimize the total travel time of all evacuees as well as there will be no rush in a single place. Earthquake prone regions like Dhaka city especially in Lalbagh must have an evacuation road map. This study will be a great instrument for the policy makers to rethink about further research on GIS technology for earthquake response. It will open the doors for community people to easily understand and participate in emergency response activities like safe evacuation, search and rescue which can greatly help in earthquake risk reduction and minimize loss of life. However it will strengthen the total response mechanism of the government by analyzing road connectivity and suggesting new routes which will be enhanced by the participation of community people.

## **RECOMMENDATIONS**

Lalbagh area are existing narrow roads need to be expanded for better evacuation opportunity and the number of residents in a building should strictly be controlled in consideration of Floor Area Ratio (FAR) for Lalbagh city.

Community of Lalbagh city initiatives like joint roof and its probable consequences need to be examined. Department of Disaster Management (DDM) should support ward disaster management coordination group for better and efficient performance in Lalbagh. Increase awareness program in Lalbagh's community level as they will be more willing in responding to emergency response activities. There should be proper management of safe evacuation places. Every family should have an evacuation plan as they need not to think of other family members if an emergency situation creates. Community leaders should encourage people in mock drill activities. So people will better understand about the use of evacuation route and strictly follow the Earthquake Contingency Plan Dhaka City Corporation.

Most of the building are old and not maintained the building code, so if possible building should be reconstructed. This program bears very highly cost. Owner only cannot bear the construction cost. Government and other organization must help the program. Concrete share wall building type is considered to be earthquake-resistant. These buildings performed extremely well in earthquake. It maintains mainly low lost. Stone column is an acceptable technique for improving soil conditions. During an earthquake, stone columns can also act as a gravel drain column to release pore water pressure and the liquefaction potential of a ground can be reduced (Soil and foundation stability improvement by stone column). The modified stone column is cost effective. Alternatively, soil condition can also be improved by injecting a fluidized material. Reinforced short pile is also considered as one of alternative methods to improve the stability of the structure or buildings and avoid the liquefaction damages to the structures or buildings.

## REFERENCES

1. Moroni, M. O. (2002). "Concrete Shear Wall Construction", *University of Chile, Santiago, Chile*.
2. Mitchel, J. K. and Huber, T. R. (1985). "Performance of a stone column foundation", *J. Geotech. Eng.*, ASCE. 111(2): 205-223.
3. Shenthan, T., Nashed, R., Thevanagayam, S., Martin, G. R. (2004). "Liquefaction mitigation in silty soils using composite stone columns and dynamic compaction". *Earthquake Eng. Eng. Vibration*, 3(1): 39-50.
4. Kamal, A. S. M. M. (1998). "Influence of Neotectonics on the Platform development of the Brahmaputra-Jamuna River, Bangladesh, in the Context of Regional and Local Morphotectonics ", M.Sc. Thesis, International Institute for Aerospace Survey and Earth Sciences (ITC).
5. Arman, T. H., Firat, S., Vural I. and Gunduz, Z. (2009). "Soil and foundation stability improvement by stone column": A Case Study in Adapazari City.
6. ADPC (2002). "*Community empowerment for earthquake preparedness*", Asian, P. O. Box 4, Klong Luang, Pathumthani, 12120, Thailand.
7. Ali, M. H. and Choudhury, J. R. (2001). "Assessment of seismic hazard in Bangladesh, Disaster Research Training and Management Centre", Dhaka University, Dhaka.
8. MoFDM (2014). "Vulnerability Assessment of Dhaka, Chittagong and Sylhet City Corporation Area (General building stock in cluster level)", Comprehensive Disaster Management Programme (CDMP), Ministry of Food and Disaster Management (MoFDM), Government of the People's Republic of Bangladesh.
9. Saha, M. K. (2013). "Earthquake: Emerging Threat For Dhaka City: Bachelor in Urban and Regional Planning".



10. Ahmed, S. S. (2012). "Lalbagh Thana: Bangladesh: Administrative Division", *Asiatic Society of Bangladesh*, Retrieved on 2014-07-16.
11. DCC (2011). Dhaka City Corporation (DCC), Source: [http://www.dhakasouthcity.gov.bd/http://en.wikipedia.org/wiki/Dhaka\\_South\\_City\\_Corporation](http://www.dhakasouthcity.gov.bd/http://en.wikipedia.org/wiki/Dhaka_South_City_Corporation).
12. Sucuoglu, H. and Yazgan, U. (2003). "Simple survey procedures for seismic risk assessment in urban building stocks". In *Seismic assessment and rehabilitation of existing buildings*, 97-118, Springer Netherlands.
13. ADPC (2005). "Quaternary geological mapping of Dhaka, Chittagong and Sylhet cities". Comprehensive Disaster Management Programme (CDMP) EC Support to Bangladesh Disaster Preparedness Project.
14. EMA (2005), "Evacuation Planning", Emergency Management Australia (EMA), Manual 11, ISBN: 0975047493, websource: <http://www.em.gov.au/documents/manual11-evacuationplanning.pdf>.

